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GEOGRAPHIC ASPECTS OF MODERN WEATHER FORECASTING

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- Hungary -

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FOREWORD

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[Following is the translation of an article by Dr. Laszlo Aujeszky in Foldrajzi Kozlemenyek (Geographic News), Vol VIII, No 4, Budapest, 1960, pages 372-4.]

Meteorology is now divided into two independent sciences; one is climatology and the other is prognosis or synoptics.

An opinion is often voiced to the effect that climatology is closer to geographical science than synoptics is. In the following we will look at these sciences from a new angle.

The history of science shows that the old roots of climatology are in the geographic sciences. The first great climatologists, both here and abroad, were geographic scientists. The close connection between the several branches of climatology and geography has remained unchanged, even when the sciences became more specialized. It can not be disputed that climatology, now as in the past, remains one of the bases of nature geography. Occasionally in scientific literature one can read that climatology is counted as one branch of the science of nature geography. It is superfluous to give more proof of this.

The situation is different with the younger branch of meteorology, namely, synoptics. It also has very close connections with geography, but these are not as well known, and their nature is somewhat different.

First we have to mention the origins of the word "synoptics." This name originated in the latter part of the last century. Its creation coincided with the recognition of one of the most important properties of our atmosphere, one which has become the pillar of scientific weather prognosis. This can be formulated as: "the weather of any particular region of the earth is determined mostly by events that originate on other, sometimes distant, parts of the earth."

Even today this fact is not very well known among laymen. Many think, for instance, that a major rain comes about by local circumstances. If on a smaller, for instance 1,000 km², part of the Plains [Eastern Hungary] we observe a localized summer storm, people think that the necessary warmth and steam necessary for this rain is present only in the few thousand km³ air over this particular area and the whole process is independent from the meteorological state of affairs in other parts of the country or Europe.

This reasoning is wrong. A local storm over a part of the Plains

requires air which originated at much cooler parts of the earth's surface. In summer months this air comes from the central parts of the North Atlantic. It is also necessary that this air (which only very seldom comes in a straight path) is not subjected on its way to drying effects. These drying effects come about by passing over very dry and hot surfaces. Furthermore, the air should not "stumble over" the ridges of major mountains, because the well-known foehn dries the traveling air masses. The storm-making properties of this air mass are improved if it has 1-2 days of undisturbed sunshine while traveling. The sunshine must have a higher-than-average portion of ultraviolet rays. Ultraviolet rays increase the number of ions in the air; this contributes to its storm potential.

The example above clearly shows the validity of our statement.

Meteorological phenomena occurring over larger areas depend even more on events a large distance away. During nation-wide rains and winds, Hungarian weather is only a part of the overall European picture.

Other geographical phenomena do not show this dependence on distant events. Soil changes, erosion, rock destruction, etc. all depend on processes occurring near, on, or in the ground. The distinctive differences of the atmosphere (from other earthly physical masses) lies in the fact that various physical processes and effects propagate in it very quickly over vast distances.

The scientific prognosis of the weather is based on these natural phenomena. The scientific method utilizes the fact that there is a very close link between distant points of the atmosphere. In order to get a prognosis it is necessary to have a complete view of the state of affairs over very large sections of the earth. This overall view is called synopsis, and the prognosis method based on it is synoptic meteorology.

Synoptics needs maps. The modern meteorological prognosis stations employ large maps. The selection of the most useful map projections was based upon many years of experience, and is regulated by international standards. International standards are used in the scaling of these maps as well. The most important meteorological maps use a scale of 1:5 million and 1:10 million. Maps encompassing a hemisphere have a 1:30 million or 1:40 million scale. The maps should have the more important features (mountains, water ways) of the given continents. These are the maps that are used for showing the data of the atmosphere at any given moment.

The International Meteorological Service broadcasts data every three hours. Hence, eight synoptical maps can be prepared daily. The maps inform us of the weather conditions of Europe, Western Siberia, the Near East, North Africa, and the North Atlantic (which includes, of course, the area bordered by Greenland, Iceland, and the Swabards; this area greatly affects the weather of Europe).

Beside the eight synoptical maps, two maps are prepared daily at specified times. These "main" maps are vitally important in modern forecasting. They give the view of the whole Northern Hemisphere, including Asia, North America and the Pacific.

Radio feelers recording the conditions in the stratosphere supply data for other maps. The most important of these is the map giving the conditions in the middle part of the troposphere, at about 5 1/2 km from

the earth's surface. The present stratosphere map contains the data obtained from more than 100 European radio-balloon stations. Since the weather originates in the inner parts of the troposphere and not in the lower regions, these maps are of great importance.

The links of modern synoptics to geography are not limited to the similarities described above. The links to geography are much deeper, for an analysis of the obtained data also contains important features characteristic of the methods of geography.

The task of the meteorologist is not finished with the completion of weather maps. Registration of the present state is only the first step in his work. A more important and interesting aspect awaits him: he has to find the direct reasons for the happenings. If he sees a great area of rain on the map, he has to give reasons (according to the well-known laws of physics) for why it rains and why at that particular area. Only when the physical reasons are completely understood can he proceed to the third, most important, and most engaging phase of his work, namely, forecasting the future from the present state.

The second step, the reasoning of the origins of the present weather, is called meteorological map analysis. Geographic considerations constantly and abundantly enter into this work. Weather conditions come about for two reasons. One is the effect of the earth's surface, e.g., the mountains and their relation to the plains (orographic factors) the soils and their different warming properties and moisture economy, sea currents, sea waves, icebergs -- all effect the weather. The second reason is a group of effects that originate from previous weather. Such are the presence of snow cover, the wetness of a particular surface, the heat and moisture stored in the atmosphere, and the ion population of the air. It is obvious that consideration of the effects of the first group involves thorough geographic knowledge. This knowledge should extend not only to the geography of any particular country but to a large area of the globe.

The projection of the present into the future also brings up several geographic problems. A large part of weather phenomena moves quickly on the earth's surface. The meteorologist must predict the speed and the course of these mobile weather processes. The free movement of the air mass has important geographic limits, however. The uneven, changing course in itself constitutes an obstacle in the path of the air masses because it increases friction in the lower parts of the moving air. The friction consumes the energy stored in the moving air, turns it into heat. Hence, if an air mass is predicted to pass over water-covered areas where the surface friction is negligible, it will come out as a different product from an air mass which passed over a plain. Even larger differences exist if the air has to face orographic obstacles.

It has become obvious from the above that a meteorologist in his everyday work has to know and apply a great deal of geographic facts and knowledge. It is also obvious that this second branch of meteorology is as strongly tied to geography as climatology is. The links of both sciences to geography are two-directional; i. e., in some cases geography is the basic science whose facts are applied by both the climatologist and the synoptician, and in some cases only by knowing climatology and synoptics can a geographical question be solved.